The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

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The March of Synthetic Chemistry

ONCE a train of events has been put in motion it is often impossible to trace the ultimate effects. It was not particularly difficult to deduce that with the development of the synthetic dye industry and the discovery of synthetic turkey red and indigo the cultivation of the madder plant on tens of thousands of acres in Southern France would die out, and there would be widespread distress among those millions of agricultural labourers in India who were occupied with the large-scale cultivation of the indigo plant. But it would have required something more than ordinary acumen to deduce that the invention of the motor car would ultimately affect the economics of soap making. That seems to be the ultimate deduction from the interesting paper by Dr. Williams on the synthetic production of glycerine which is reproduced in this issue of THE CHEMICAL AGE. The curious effect here referred to has come about by the development of cracking to produce the petrol needed by the automobile industry. Among the "waste" gases so produced is propylene, which is the basis of the Shell Company's synthetic method of glycerine production.

It is by now clear that the use of any source of carbon such as petroleum or coal as a starting point for chemical synthesis depends primarily on the production of simple chemical compounds which can be halogenated sulphonated, nitrated, and so on, in order to produce the necessary intermediates. The method generally used is that of cracking, whereby the less reactive paraffins are converted into olefines. It is not without significance that by the processes of hydrogenation or by the Fischer-Tropsch process, suitable raw materials can be produced from coal. From the Fischer-Tropsch process these are already to some extent in the form of unsaturated hydrocarbons, whereas those produced by hydrogenation would probably require to be cracked. The Germans are said to be already producing propylene from the Fischer-Tropsch synthesis for the manufacture of glycerine and that this glycerine is combined with suitable fatty acids to produce a mixture of glycerides which forms the basis of the synthetic butter now inflicted upon the population of that country. During the last war Germany produced glycerine to the extent of two thousand tons a month by fermentation of beet sugar in the presence of sodium sulphite. In the U.S.A. the sulphite has been replaced by carbonate with the result that the fermentation process gives much greater promise of eventual commercial value. Possibly a still more promising method for the production of glycerine from coal is that patented by E. I. du Pont de Nemours and Co. by which the condensation of CO with formaldehyde produces glycollic acid. This in turn reacts with a formal to produce a formaldehyde derivative of glycerine from which glycerine itself is readily produced by alcoholysis.

The speed with which these synthetic processes have been developed may be judged by a passage in a book on the subject, written not more than three years ago, in which it was stated that none of the synthetic processes "have been developed to any extent commercially as yet. They depend chiefly upon a cheap source of raw materials. The most promising raw material is from unsaturated petroleum gases. Some day synthetic glycerine produced from this will become a very serious competitor of soap-lye glycerine."

This introduces the problem of economics, and it is noteworthy that Dr. Williams himself believes that the present economic position of the glycerine markets hardly indicates that the time for synthetic glycerine is immediately at hand, but he believes that a second source of supply would stabilise prices. It does not appear, however, that prices require any stabilisation. During the war of 1914-18 the military demand for nitro-glycerine was reflected in steadily rising prices for the crude and refined product, and in the increasing difficulty in securing supplies for non-explosive uses. A great many substitutes were used, particularly in the textile industry, and some of these are still in use. Prices have been so far stabilised during this present war, however, that the first increase in price since March 3, 1939, amounting to only 5s. per cwt., has just been announced by the U.K. Glycerine Producers' Association. Similarly the glycerine market in America continues to be very steady. There is a voluntary rationing scheme in operation in this country and in America there is no difficulty in meeting increased demands. The chief reason for the stability now appears to lie in the increase in the international output of glycerine. It has been estimated that the world production of 80 per cent. product has increased from 135 million lb. in 1913 to 350 million lb. in 1939, this being caused chiefly by the growing production and consumption of soap, the increased demand for fatty acids and the utilisation of new raw materials such as the hydrogenated fish oils now being employed in Japan. Moreover, almost every soap works now recovers glycerine, whereas previously glycerine was recovered only by the larger works and that not always very efficiently. Dr. Williams's cautious estimate of the prospects of synthetic glycerine appears to be justified.

NOTES AND COMMENTS

Payment of War Risks Claims

THE Board of Trade is making a fresh drive to speed up both payments on account and final settlement of claims under the commodity insurance scheme of the War Risks Insurance Act. Directions prepared by the Board showing how this may be done are now being sent through the Board's Agents—the insurance companies and Lloyds who issue the policies—to every trader in the country whose stocks are insured under the scheme. About 250,000 traders are insured. Meanwhile, the Board calls attention to their readiness to facilitate prompt payments on account of claims where from any cause final assessment may be protracted or a trader is likely to suffer hardship from lack of financial means pending final assessment and settlement. Traders who have already sent full particulars of their claims to their insurance companies or Lloyds and wish to obtain payment on account are invited to apply direct to the Board's assessor dealing with the claim. Where completed particulars of claims have not been given a trader desiring payment on account should write to the Agent—the insurance company or Lloyds—through whom the policy was issued. No special form is needed, but the policy holder should state (a) the address of premises where loss occurred; (b) date and cause of loss; (c) nature of goods; (d) estimated amount of loss allowing for salvage; (e) grounds of application for payment in advance of final settlement.

Speeding Up Exports

STEPS are being taken by the Board of Trade to speed up shipment of goods for export. "We wish to quicken the turn-round of shipping at ports, avoid waste of accommodation in dock sheds, lessen the strain of road and rail transport and ensure a smoother flow of goods through the ports," an official of the Board of Trade said recently. Exporters who experience difficulties in obtaining rail transport are urged to get into touch promptly with district goods officers of the railway companies. Many difficulties, it is said, can be overcome in this way. Others can be dealt with by the Board of Trade representatives on the Area Boards under whom in some areas Board of Trade transport officers are already working. Exporters should also be guided by their own agents as to the right time for sending their goods forward. "Much delay has been caused and in some instances goods have had to be sent all the way back from docks to the manufacturers," the Board of Trade official said, "by the failure of a number of exporters to acquaint themselves and comply with export control requirements which are essential in wartime. Before goods leave the country it is necessary that full details about them be supplied to the Customs authorities so that the goods can be 'pre-entered' and checked. Particulars of pre-entry requirements may be obtained from the Customs. Full information about exchange control can also be given by the Customs or by any bank. Shipment of goods for export will be considerably speeded up if every exporter will see that as far as possible entry forms have passed through the Customs before goods are sent to the docks. Customs authorities have simplified and speed-up the procedure on their part as far as possible. For certain Empire destinations they have also suspended for a trial period the requirement of pre-entry for goods not on the prohibited list. It is not possible to go further in this direction without sacrificing the essentials of export control. It is up to exporters now to do their part. After they have acquainted themselves with what is required, they should complete the necessary forms or give their shipping agents the necessary information to complete them as much in advance of the prospective date of shipment as possible. Where a currency declaration (form C.D.3) is required for exchange control purposes, this should be completed by the exporter and submitted to the Customs with the pre-entry."

Lignin

THE possibility of adding a plasticiser to wood that will so soften the lignin—the main component, with cellulose, of woody tissue—that when it is hot the wood may be twisted into various shapes—this was the most striking feature of an address recently given by Dr. Elwin E. Harris, of the Forest Products Laboratory, Madison, Wisconsin. Dr. Harris explained that phenol and formaldehyde both react with lignin, causing it to soften. If wood is treated with such a mixture in a water solution, these chemicals enter completely into the structure of the wood, and if heated and pressed, a new wood composite is obtained in which a lignin-phenol-formaldehyde plastic holds the cellulosic fibres more tightly together than in the original wood. Over a century has passed since lignin was first recognised as a constituent of plant material, but it is not yet understood because it does not readily split up into identifiable building units, as is the case with cellulose. It is not possible to give a chemical definition for lignin. Dr. Harris says the best definition we have is that "lignin is a carbohydrate material remaining after plant substances have been freed from tannins, pectins, waxes, fats, proteins and other similar compounds." Work is being done towards a complete understanding of the structure and nature of lignin and with the solution of these, many channels might be opened for the use of this abundant material, most of which now goes to waste.

Training Industrial Workers

THE publication, by the National Institute of Industrial Psychology, of a pamphlet on training has aroused much interest, and it has been suggested that a number of firms would welcome assistance in the establishment of a training scheme along the lines found most effective. The Institute, accordingly, proposes to hold a short lecture course to which firms may send the member of their staff who is, or is to be, responsible for training; the general instruction on principles given at the lectures will be supplemented by practical assistance in the factory in the course of two visits from a member of the Institute's staff. The aim of these visits is to ensure that the general methods advocated by the Institute are adapted to the special needs of the firms concerned. The general course, which will last three days, will consist of lectures, illustrated by films, and discussions. It will be held at Aldwych House on March 14, 15 and 16 for those who can attend only at a week-end, and will be repeated on March 19, 20 and 21 for those who find a mid-week period convenient. The investigator's visits to the factories will follow at appropriate intervals. The first visit will normally last a week, while the second, of one or two days, will be in the nature of a follow up to review the progress made, and to advise on any problems which have arisen. Further details may be obtained on application to the Director, National Institute of Industrial Psychology, Aldwych House, Aldwych, London, W.C.2.

The Influence of Synthetic Rubbers on Plastics

Widening the Commercial Field

by HARRY BARRON, Ph.D., B.Sc., A.I.C., A.I.R.I.

It has often been said that synthetic rubbers occupy an intermediate position between rubber and plastics. The relation between synthetic rubbers and raw rubber has been discussed at great length by many authorities. Singularly enough, comparatively little has been heard about the potential influence of synthetic rubbers on the other group of border materials—plastics.

Synthetic rubbers will, undoubtedly, have a very profound effect on plastics activities. This applies not only to the technical aspect, but also to the wider commercial considerations. In particular, they will affect the thermoplastics of the vinyl group, including such well-known materials as polystyrene, polyvinyl chloride, acrylic derivatives, polymethacrylates, etc. Synthetic rubbers in general (excluding the anomalous type of synthetic rubber exemplified by Thiokol) have a great deal in common with these thermoplastics, nearly all being based on butadiene (or divinyl) as the fundamental unit. *A priori* one can anticipate certain relationships between compositions based on the vinyl grouping and compositions based on the divinyl grouping.

TABLE 1.

$CH_2 = CH_2$	...	Ethylene.
$CH_2 = C <$	...	Vinyl group.
$CH_2 = CHCl$	...	Vinyl chloride.
$CH_2 = CH.C_6H_5$	...	Vinyl benzene (styrene).
$CH_2 = CH.COOH$	...	Acrylic acid.
$CH_2 = CH.CN$	...	Acrylic nitrile.
$CH_2 = CH - CH = CH_2$	...	Butadiene (divinyl).
$CH_2 = C.CH_3 - CH = CH_2$		Isoprene.
$CH_2 = C.Cl - CH = CH_2$	...	Chloroprene (for neoprene).

As a matter of fact, both types of products have progressed side by side. All derive from ethylene. Invariably, they are obtained from the same raw materials, chiefly coal, generally from acetylene via carbide. Earlier raw materials were cereals, potatoes, sugar beet, etc., but these were displaced by carbide. In turn, carbide has now been ousted as the cheapest source of ethylene for butadiene; this can now be obtained by the cracking of gas oil wastes from petroleum.

The processes earlier applied to the production of vinyl derivatives have been used with equal success for divinyl compounds. In developing synthetic rubbers it has been necessary to cover the whole ground of vinyl chemistry, and generally the work has proceeded side by side in the same laboratories. Thus, concerns which have had success in the production of vinyl plastics have almost invariably proceeded to the production of synthetic rubber. As examples, we can quote the I.G. in Germany, which runs the entire gamut of plastics and synthetic rubbers; Du Ponts in the United States; Goodrich, who brought out Koroseal polyvinyl chloride a number of years ago, and have now developed a synthetic rubber, " Hycar "; and others.

There is no longer any hard and fast line between vinyl plastics and synthetic rubbers. The division becomes more and more obscure as time passes, so that there are many plastics, such as polyvinyl chloride, with rubbery properties Indeed, this is often referred to as a synthetic rubber. We are coming to a state of affairs where production of synthetic rubber implies production of vinyl plastics, and vice versa.

Slow Progress of Vinyl Plastics

There can be little doubt that synthetic rubbers will be the direct cause of establishing many vinyl plastics on a firm commercial foundation. During the last ten years vinyl plastics have been making great progress, but at a comparatively slow rate. The great drawback to more rapid advance has been the cost. The best known commercial vinyl plastics include polyvinyl acetate, polyvinyl chloride, polyvinyl alcohol, polyvinyl acetal, polystyrene, polyvinyl acrylic ester, and polyvinyl methacrylic ester. Some of these have established themselves firmly, but in the ordinary way they could hardly expect to attain bulk markets for some time to come. The demand for each has had to be created, always a laborious and expensive process. In each case there has been the usual vicious circle which invariably holds up development, namely, that the demand is not large enough for large scale production; without large scale production the cost is very high, and this necessarily throttles demand. There is only one example where a large market has immediately existed for a vinyl material. This is the production of vinyl butyral for safety glass, in the United States. It required a terrific joint effort and considerable expense. In this case, a very large tonnage outlet was immediately available, the material being developed for the specific purpose of the sandwich layer in safety glass. It is the outstanding example of the creation of a plastic to specification, and is exceptional. Other materials have to wait for some unexpected influence to break the vicious circle. For many vinyl resins this seems at last to have come about through the drive for the production of synthetic rubbers. It has happened in the following manner.

A Changed Objective

While efforts have been made for many years to produce satisfactory synthetic rubbers, it is only comparatively recently that there has been any marked alteration in the objective aimed at. Hitherto, all efforts were directed at making close imitations of natural rubber, and so long as this remained the case there could be no commercial prospects for synthetic rubber. For a number of years, ever since the plantation industry became well established and got into its stride, this has indeed been evident. It was all very well when rubber was obtained from the wilds, being dirty, variable and expensive. But when once rubber could be produced on the plantations at so low a basic figure as 4d. per lb., there could be little hope for the future of an exact synthetic imitation. The early isoprene rubbers of Tilden, Bouchardat, Williams, and others were mere academic curiosities. Even the products obtained by Harries, Hofmann, Matthews, and Strange just before the last war came into this category. They served, however, the very useful purpose of supplying the guiding lines for future work, and provided the necessary technical background for subsequent production.

That was one aspect of synthetic rubber production. The other angle was this. It has been obvious for the last decade that the versatility of rubber could no longer cope with the increasingly specialised requirements of modern industry. Consequently, there was no sense in trying to imitate the deficiencies of rubber. This is the point of departure between traditional aims and modern practice. The first deviation from the idea of exact imitation of rubber—neoprene based on chloroprene instead of isoprene—was a great success. There has been no enormous expansion of output of neoprene simply because it was treated as a straightforward commercial material supplementing the uses of rubber, and production was based on this premise.

Until a few years ago synthetic rubbers were produced by straightforward polymerisation of simple isomers. The isomers were similar to isoprene, being homologues, *e.g.*, butadiene, dimethylbutadiene, etc. The production of these isomers was in itself a great task. Even now the final cost of synthetic rubber depends chiefly upon the cost of the monomer. In due course, after a lengthy weeding-out process, it has become generally accepted that butadiene is the best starting material, and production of most types is based

upon this. By dint of strenuous efforts butadiene is now obtainable at a reasonable cost in bulk.

In due course it was also recognised that synthetic rubber made by straightforward polymerisation of butadiene or derivatives had distinct limitations. Then came the principle which has revolutionised synthetic rubber production. This was the addition of a different monomer as an integral part of the material by copolymerisation.

Copolymerisation

The principles of copolymerisation had been making headway in plastics production, particularly with vinyl derivatives, a notable example being the polyvinyl chloride-acetate copolymers. These were quite closely allied to the divinyl butadiene derivatives, used in synthetic rubber production. If vinyl derivatives could be polymerised together, why not divinyl derivatives? They could. The merits of copolymerisation have not yet been fully recognised. For synthetic rubbers it has proved as fundamentally important as was the discovery of vulcanisation for raw rubber. The most important feature was that the additions were almost invariably synthetic resin monomers of the vinyl family. Those chiefly used for synthetic rubbers are styrene and acrylic nitrile.

This is the fundamental discovery which has put synthetic rubbers on a stable foundation. It has enabled them to depart from the old tradition of simulating natural rubber, and has led up to the production of specialised rubbery materials. Instead of the inferior rubbers produced by straight polymerisation of a diene, by contrast, each copolymer of butadiene and a synthetic resin has been found to possess the general desirable rubbery properties, plus some extra specialised characteristics. The subject is still in its infancy, and there is no knowing where future developments will lead.

It should be realised that the mechanism of polymerisation was not made to function smoothly without a great deal of difficulty. The polymerisation process was not so straightforward; in fact, it was a decidedly awkward problem. The first practical method was developed almost simultaneously by Matthew and Strange in England, and by Harries and the Bayer Co. in Germany. This was based on a lengthy heat treatment of a diene in the presence of sodium under pressure. Sodium polymerisation was the principal method, until quite recently, the form in which the metal was present being the chief variant. Quite lately there has been a great step forward by the use of emulsion polymerisation—a technique borrowed from plastics. For example, nowadays, butadiene and acrylic nitrile are polymerised in aqueous dispersion so as to form an emulsion of synthetic rubber, somewhat similar to rubber latex. From this, pure regular products may be obtained.

Copolymerisation has made synthetic rubbers into potentially commercial materials. It has brought them out of the laboratory and on to the market. By varying the nature of the plastic used and the amount, it has facilitated the production of synthetic rubbers having specialised properties. Specialisation is the crux of the whole problem when we come to the question of the commercial prospects of synthetic rubber *vis-à-vis* raw rubber.

So far I have shown the close technical relationships which bring synthetic rubber and plastics together. But the fact that there is large-scale production of synthetic rubbers in which considerable proportions of synthetic resins are used has resolved another difficulty. The principle of copolymerisation is directly responsible for breaking the vicious circle which hampered the extremely useful vinyl plastics. For with large-scale production of specialised synthetic rubbers owing their properties to the incorporation of proportions of these plastics, there has come an immediate and correspondingly large demand for the products. The implications of this are obvious. Immediate large-scale production of these vinyl resins becomes necessary. The capital expenditure and other commercial considerations for their production are considered as part of the synthetic rubber manufacture. Automatically, the cost of the plastics is considerably reduced. In fact, any excess production may profitably be diverted into the plastics industry. This is no mere hypothesis, there are examples already available.

Effect on Production

Already there is large-scale production of synthetic rubbers. Germany is producing at a rate said to be in excess of 50,000 tons per annum. Russia has a considerable production. In these cases production can hardly be considered as commercial, being based on the idea of self-sufficiency and being paid for accordingly. This fact has no bearing on the issues raised in this article. But now a number of United States firms are in production of commercial synthetic rubbers. These include Goodyear, with Chemigum, which is a copolymer of butadiene and an acrylic derivative; Standard Oil of New Jersey, and Firestone with buna rubbers similar to the German; Standard Oil Development with butyl rubber, a copolymer of an olefine with a diolefine; and Goodrich and Phillips Oil, with "Hycar," which is butadiene with an acrylic derivative. Du Pont's are stepping up roduction of neoprene, and to complete the roster, Dow's are increasing Thiokol production. In all, private production is working at the rate of 20,000 tons per annum. The United States Government, by way of insurance against any possible shortage of raw rubber, is likely to assist production up to 100,000 tons. These activities introduce a new factor which accounts for the ability to produce at low cost—namely, the use of oil wastes as raw material to supply butadiene. But that is another story. It seems highly probable that within a few years there will be an annual production of 150,000 tons commercial synthetic rubber possibly at 1s. per lb.

TABLE 2. ESTABLISHED SYNTHETIC RUBBERS.

Synthetic Rubber.	*Manufacturer.*	*Date Available.*	*Composition: Polymers of*	*Raw Materials.*
Neoprene	Du Pont	1931	Chloroprene	Carbide.
Thiokol	Dows	1931	Ethylene Polysulphide	
Perduren	I.G.	1935	,, ,,	
Buna 85	I.G.	1935	Butadiene	Carbide.
Buna S	I.G.	1935	Butadiene & STYRENE	Carbide & Coal.
Perbunan	I.G.	1936	Butadiene & ACRYLIC NITRILE	,, ,,
Hycar	B.F. Goodrich Phillips Oil Corp.	1940	Butadiene & ACRYLICS	Oil Wastes & Coal.
Chemigum	Goodyear	1940	,, ,,	,, ,,
Butyl	Standard Oil Development	1940	Olefines and Diolefines	Oil Wastes.
Buna	Standard Oil of N.J. Firestone	1940	,, ,,	Oil Wastes & Coal.
Vinylite	Union Carbide & Carbon Corp.	1930	VINYL CHLORIDE	Carbide.
Koroseal	B.F. Goodrich	1934	,, ,,	
Mipolam	I.G.	1935	,, ,,	

German production of bunas is based upon butadiene with styrene and acrylic nitrile, as auxiliary co-monomers. Other synthetic resin monomers are also being used, but not on the same scale. The United States trend is towards use of similar materials.

Until recently neither styrene and acrylic nitrile has been a major plastic in the sense of large tonnage consumption. In the United States the amounts used in 1939, according to *Modern Plastics* (*17*, 26, 1940), were about 2000 tons of acrylic resins and about 300 tons of polystyrene.

Polystyrene is a superb electrical material. It has excellent optical properties and is an extremely facile material for all moulding purposes. It is, however, somewhat brittle, and the price has been much too high for wide use. Even in Germany, where they have specialised in polystyrene production, this too is the case. Its application has been restricted to mouldings of high electrical characteristics.

A similar state of affairs exists with regard to acrylic derivatives. These have a larger market than polystyrene in the United States and Great Britain, because of their outstanding optical properties, best of any known material, and because of their great strength and toughness. There is a comparatively small but growing market for specialised transparent materials for aircraft, display purposes, injection moulding, etc., and for textile impregnation. But in neither case has there been a large-scale demand which would enable the price to come down by virtue of correspondingly large-scale production.

Injection Moulding

One of the major plastics activities is injection moulding. It is practised on a very great scale in the United States, in Germany, and in Great Britain. The most widely used material is cellulose acetate, which is very cheap, and the ever-growing consumption runs into many thousands of tons. Yet according to the trustworthy authority of *Modern Plastics* (*loc. cit.*), 90 per cent. of injection moulding in Germany is now carried out with polystyrene compositions. There is also a considerable outlet as substitute for glass, for example, in aircraft and for lenses, etc. No less spectacular is the expansion in the use of polyacrylic derivatives. How can these apparent anomalies be explained? Even totalitarian economics cannot account for these facts.

Impending Price Reductions

It seems clear that German synthetic rubber production is responsible. The chief types made are Bunas and Perbunan, estimated at 50,000 tons per year. Even assuming an equal division and a 20 per cent. plastic content, this demands 5000 tons each of styrene and acrylic nitrile. With production on this scale, any excess can be diverted into the plastics industry at low cost. Furthermore, with such large quantities available, urgent questions such as the provision of suitable plasticisers, particularly important for polystyrene, etc., must in due course be solved.

The same trend is evident in the United States. The great activity now brewing in the production of synthetic rubbers calls for considerable quantities of styrene and acrylic acid derivatives. Automatically, large-scale production of these has been inaugurated. This is already reflected in the fact that quite recently acrylic nitrile has become available on the open market for the first time in commercial quantities. Butadiene can likewise be purchased in bulk. By virtue of impending price reductions the way is now clear for big tonnage outlets.

There can be no shadow of doubt that production of synthetic rubbers is already stimulating vinyl plastics, not only technically but commercially. The artificial stimulus of the German production is likely to be replaced by the commercial manufacture in the United States. Although in the immediate future polystyrene and acrylic plastics will be the chief beneficiaries, the whole subject is in such a state of flux that possibly many other vinyl plastics may come into use. The vinyl butyral for safety glass may find its counterpart in some new vinyl plastic for synthetic rubber.

Jet Test for Silver Coatings

Thickness Determined by Iodine Solution

THE method of determining the thickness of certain thin metallic coatings by the B.N.F. Jet Test is well established, and consists in observing the time necessary to effect perforation of the coating by a jet of corrosive liquid which is allowed to impinge upon it under standardised conditions. The rate of penetration is influenced to a marked extent by the temperature of the jet reagent, and in practice the thickness of the coating is calculated from the perforation time with the aid of a calibration curve relating the rate of penetration with the temperature of the reagent. Full details of the method have been given by S. G. Clarke, *J. Electrodepos. Tech. Soc.*, 1937, *12*, 1 and 157.

A recent report, presented to the Electrodepositors' Technical Society by R. A. F. Hammond, of the Research Dept., Woolwich, describes an extension of the jet method to the testing of silver deposits. It has been found that a solution of iodine in potassium iodide, when used as a jet-testing reagent, produces rapid penetration of electrodeposited silver coatings. The rate of penetration is controlled by the concentrations of both iodine and potassium iodide in the reagent and by its temperature. A convenient rate of penetration is provided by a solution containing 250 gm. of potassium iodide and 7.44 gm. of iodine per litre, and this composition was therefore selected for calibration.

The reliability of the test has been confirmed by trials on commercial silver deposits, and full details are given in *J. Electrodepos, Tech. Soc.*, 1940, *16*, 69-82.

Aconitic Acid Resins

Improved Colours Obtainable

WHEN aconitic acid (an unsaturated tricarboxylic acid) is condensed with a terpene or terpene alcohol, the resulting resin is dark in colour and otherwise unsuitable as a varnish ingredient. In this respect it differs from maleic acid (an unsaturated dibasic acid) which condenses with terpenes to form resins of excellent quality. The Petrex resins introduced a few years ago belong to the latter family.

Pale-coloured resins have now been produced from aconitic acid by simultaneous condensation with a terpene and a drying oil or drying oil acids as described in B.P. 530,916/1941 (Oelwerke Noury and van der Lande). In an illustrative example 141 parts destearinised train oil, 43.5 parts aconitic acid, and 75 parts wood turpentine oil were heated at 175°-210° C. for 4 hours to give a product with an acid value of 72.5. This was esterified successively with 27 parts mannitol and 3 parts glycerine (9 hours at 180°-250° C.) to a pale-coloured resin with an acid value of 25.5. The process can be operated with citric acid as the latter readily changes into aconitic acid when heated with dilute mineral acid. A solution of 100 parts citric acid in 55 parts water containing 0.5 part strong hydrochloric acid was gradually added with stirring to a mixture of 156 parts wood turpentine oil, 228 parts blown linseed oil, and 110 parts linoleic acid which had been heated to above 120° C. The temperature was gradually raised to 210° C. and held there for 8 hours, any turpentine which distilled over being returned to the reaction mixture. The product, with an acid value of 102.8, was esterified with 35.1 parts glycerine to a pale resin with an acid value of 10.6.

Synthetic Glycerine from Petroleum

The Propylene Process Described

CONSIDERABLE attention has been directed lately to the manufacture in the United States of synthetic glycerine from petroleum, and the following article, partly reprinted from *Chemical and Metallurgical Engineering* (1940, *47*, 12, pp. 834-8), is based on a paper by Dr. E. C. Williams and associates, of the Shell Development Co.'s research laboratories at Emeryville, California, presented to the American Institute of Chemical Engineers at New Orleans last December. It is essentially an account of the synthesis of glycerine by the most direct method, starting from the three-carbon skeleton, a particularly apposite method when petroleum is the ultimate starting material, in view of the unlimited amounts of propylene and propane available from this source.

Since 1856 the commercial synthesis of glycerine has been an objective of research workers. In that year Bertholet and De Luca regenerated it from tribromopropane by treatment with moist silver oxide. In 1914-18 the Germans produced glycerine by fermentation, and more recently E.I. Du Pont de Nemours and Co. have taken out patents (U.S.P. 2,211,265/6) for a synthesis of glycerine with carbon monoxide and hydrogen as the ultimate starting materials. Even with the limitation of using petroleum as a starting material, however, the number of possible syntheses is legion (*see* Fig. 2) and the method here described is the result of thousands of investigations to determine which one might have the best commercial possibilities. The synthesis finally chosen started with propylene and proceeded to allyl chloride and thence via allyl alcohol (or glycerine dichlorohydrin) to glycerine. It is emphasised that the discovery of the "hot chlorination" of propylene made the process feasible. Also, a larger-scale plant might not use the allyl alcohol step.

At the temperature used for chlorination of the propylene, propane is chlorinated rapidly to propyl chlorides which cannot be separated readily from allyl chloride by distillation. Hence, it is necessary to start with as pure a propylene as possible. A second reason for a pure feed is to avoid wastage of chlorine in unwanted by-products. Propylene of 98 per cent. purity, satisfactory for all ordinary purposes, can be obtained by rectification of refinery cracked gases, but for the pilot plant work it was prepared from isopropyl alcohol by dehydration over alumina in the ordinary manner.

Propylene may be reacted with chlorine to give propylene dichloride (1, 2 dichloropropane) by a simple addition reaction. This compound may then be converted to allyl chloride in either of two ways. U.S.P. 1,477,047 claims 66 per cent. conversion to allyl chloride by passing the dichloride over calcium chloride at 350° C., but our investigations denied this possibility and uncovered other disadvantages.

Attention was next directed to straight pyrolysis of the dichloride (U.S.P. No. 2,207,193; Shell Development Co.). Though satisfactory for making allyl chloride, it has certain disadvantages and could not be considered a happy solution to the problem.

Consequently the direct chlorination of propylene to allyl chloride, without an intermediate product, was next studied. Ordinary chlorination results in addition at the double bond with the formation of propylene dichloride as described above. But arising from similar work done in the Shell laboratories on butylene, it was discovered that at elevated temperatures (500° C.) chlorination resulted in the direct attack of the methyl group with the consequent formation of allyl chloride in yield of the order of 85 per cent.

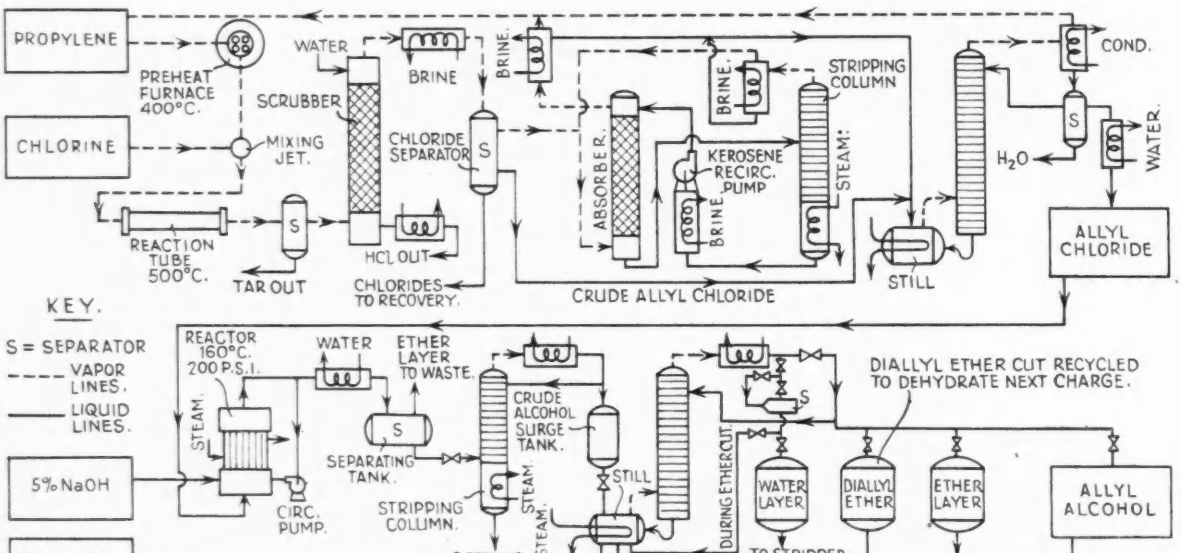


Fig. 1. Flow-sheet of the synthesis of glycerine from propylene actually in use

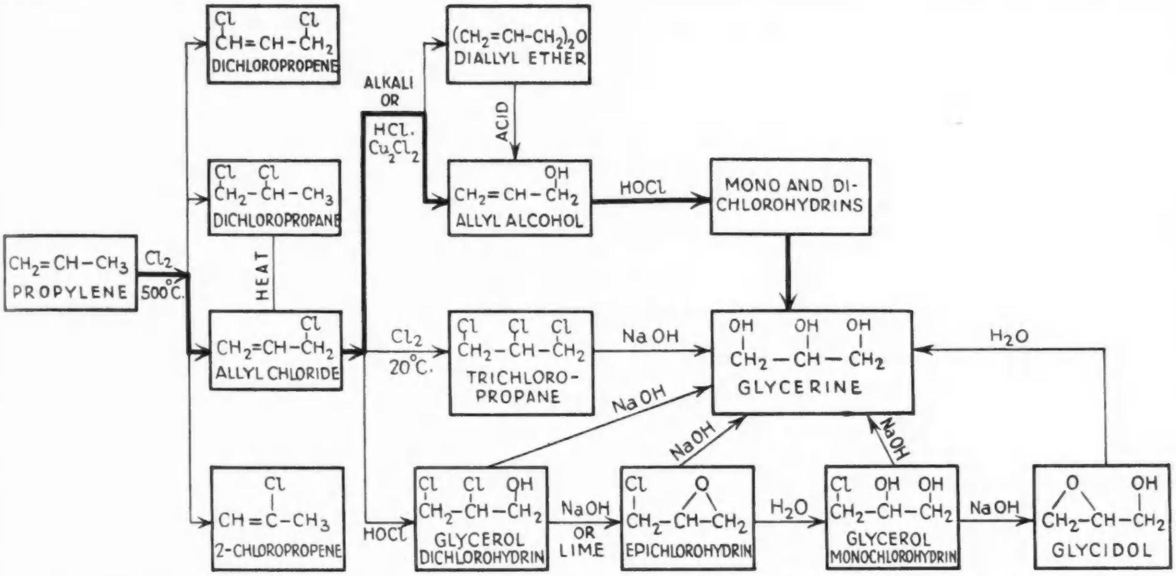


Fig. 2. Reaction chart illustrating the possible syntheses of glycerine, using propylene as starting material

$$CH_2=CH-CH_3 \xrightarrow{500^\circ C.} CH_2=CH-CH_2Cl$$

This is the "hot chlorination" process mentioned above.

Having a successful laboratory-scale process for allyl chloride, the next problem concerning this first step in the glycerine synthesis was pilot plant development. As finally worked out the 2000 lb.-per-day pilot plant produces allyl chloride as shown in the upper part of the accompanying flow sheet. (Fig. 1).

Control of chlorination reaction around 500° C. is maintained by preheating the propylene to about 400° C., then introducing the chlorine into an efficient mixing jet. The heat of the reaction, which is almost instantaneous, is allowed to raise the temperature of the reactants to 500°-530° C., at which temperature best yields of allyl chloride are obtained. The actual reaction, initiated immediately after the mixing, takes place in a simple steel tube which is insulated sufficiently to allow the reaction temperature to rise to the desired level.

Both the ease of temperature control and the avoidance of over-chlorination of di- and trichlorides are benefited by feeding a large excess of propylene over the theoretical amount required for reaction with the chlorine. Increasing the propylene ratio from 3.0 to 5.0 led to an increase in allyl chloride formation from 66 per cent. to about 80 per cent. of the theoretical. Also, within the range of this test the increase was linear. Limitations of the plant recovery system prevents experimentation at higher ratios and cost of the recovery system leads to an economic compromise in the commercial plant.

The type and efficiency of the mixing jet for propylene and chlorine also plays a large part in the formation of higher chlorides. Satisfactory results were obtained with the type described by Chilton and Genereaux (*Trans. A.I.Ch.E.*, 1930, *25*, 102). The time of residence in the reaction zone is not too critical, provided sufficient time is allowed for completion of the reaction.

No difficulties are experienced from corrosion at any point in the reactor equipment. No particular care is taken to dry either chlorine or propylene; indeed, the latter is fed to the plant from a water-sealed gas holder.

The vapours leaving the reactor consist of unchanged propylene, unsaturated monochlorides, unsaturated and saturated dichlorides together with small amounts of higher boiling chlorinated hydrocarbons and HCl. These products are separated and recovered individually by suitable processes of extraction and rectification. The HCl may be recovered either anhydrous or as aqueous commercial acid.

The second step in the synthesis of glycerine is the hydrolysis of allyl chloride to allyl alcohol. Actually glycerine can be synthesised without going to allyl alcohol at all. As shown on Fig. 2 there are at least two alternative routes. Allyl chloride may be further chlorinated to trichloropropane quite easily. Hydrolysis of the trichloride to glycerine, however, proved a serious obstacle and this line of synthesis was abandoned.

The second alternative process, direct chlorohydrination followed by hydrolysis, merited more serious consideration. Several workers have studied the chlorohydrination of allyl chloride, but insufficient data have existed to evaluate the process accurately. It obviously requires considerably different conditions from the chlorohydrination of allyl alcohol, since the alcohol is water-soluble and the chloride substantially insoluble. To keep undesirable by-products at a minimum the reaction to best carried out in the aqueous phase. Also contact between unreacted material and gaseous chlorine is to be avoided because chlorine tends to dissolve preferentially in the non-aqueous phase, again giving undesirable by-products. In view of these considerations, chlorine is best supplied by a solution of HOCl and NaCl, formed by reacting chlorine gas with NaOH. Glycerine dichlorohydrin is readily recovered by extraction followed by distillation. Yields of from 91 to 95 per cent. were recorded. The dichlorohydrin could then be hydrolysed with caustic soda or with part caustic soda and part lime.

These reactions are, after prolonged pilot-plant work, now considered preferable to the synthesis via allyl alcohol. However, since allyl alcohol is itself an important product, the hydrolysis step was investigated in both alkaline and acid solutions with satisfactory results (U.S.P. 2,072,016). For the alkaline hydrolysis it was found that better results are secured when using carbonate than when using free sodium hydroxide, a result dependent primarily on the difference in pH of the two reagents.

Carbonate is, however, somewhat inconvenient to use in practice, because very high pressures can develop when the evolved CO_2 is not vented. If the CO_2 is vented, volatile material is carried off with it and the pH also rises. To obtain the convenience of NaOH and the high yields obtainable with controlled pH, recourse was had to charging the autoclave with water, allyl chloride and a small amount of sodium carbonate. The mixture was heated and stirred and the pH measured constantly by means of sealed-in electrodes. As the reaction progressed NaOH was forced into the autoclave at

a rate sufficient to maintain the pH at 8-11. In this way yields of 90 to 95 per cent. were obtained.

As shown above, once allyl chloride is secured, the preferred routes to glycerine are either hydrolysis to allyl alcohol followed by chlorohydrination and hydrolysis, or direct chlorohydrination of the allyl chloride with subsequent hydrolysis. Both routes have been investigated on pilot-plant scale.

The first concern in making allyl alcohol was to make the process continuous. After investigating several reaction schemes, the arrangement for alkaline hydrolysis shown in the second part of the flow sheet (Fig. 1) was adopted. The hydrolyser consists of a tubular vessel, the hot solution recirculating so that hydrolysis takes place at somewhere near exit conditions.

As is usually the case, the variables controlling this reaction are more or less inter-related. The most important are temperature, concentration, and pH of the solution. The temperature was fixed rather arbitrarily at 150° to 160° C. This temperature is reached easily, gives a good reaction rate, and permits the use of moderate pressures (200 lb./sq. in.). The question of concentration is somewhat more complicated. The higher the concentration, the greater the loss to diallyl ether, as the following figures show:

		Composition of Products		
Normality	Deg.C.	Alcohol	Ether	Unreacted
2.5	158	82.5	11.5	6.0
1.25	157	87.5	7.6	4.9
0.625	158	93.7	3.0	3.3

Hence from this standpoint the most dilute solutions give the best yields, but this eventually is offset by the increased difficulty in recovery from these solutions. Furthermore, concentration has another effect on reaction velocity. The more dilute the solution, the faster the reaction, but of course less material is produced per unit volume. However, when both factors are taken into account, it is found that the maximum production rate per unit volume occurs at a concentration at about 1.25N, *i.e.*, corresponding to 5 per cent. NaOH as the hydrolysing medium.

Alkalinity has a fairly pronounced effect on the ratio of allyl alcohol to ether formed from allyl chloride. Thus, decreasing the alkalinity from sodium hydroxide to sodium bicarbonate causes a 30 per cent. reduction in ether formation. Consequently, for highest efficiency, this variable as well as concentration and temperature should be closely controlled. If anhydrous allyl alcohol is desired, the constant boiling mixture is dehydrated by azeotropic distillation, using diallyl ether as the entraining agent.

Allyl Alcohol to Glycerine

The ease of allyl alcohol production established, attention was turned next to converting it to glycerine. Direct addition of chlorine to the anhydrous alcohol to give glycerine dichlorohydrin in good yield has never been very successful with other workers, and our attempts over a wide range of conditions brought no great additional hope.

On the other hand, chlorohydrination in aqueous solution proceeds readily. In the first run a simple procedure was employed in which chlorine was bubbled into the well-stirred aqueous alcohol at 20°-25° C. until reaction was complete, the resulting solution neutralised and then hydrolysed for 30 minutes at 150° C. with 3 per cent. excess sodium bicarbonate. The glycerine was then recovered by neutralising the hydrolysate, boiling down the solution, filtering out the salt (which was washed with isopropyl alcohol to recover any glycerine), and finally vacuum-distilling the glycerine.

A series of runs was made in this fashion in which the only variable was the concentration of the initial aqueous allyl alcohol. The yield increases in almost a straight line relation as the concentration of allyl alcohol decreases until the highest yield, 92 per cent., is reached in the 5 per cent. solution. Incidentally, at this concentration the product of chlorohydrination is nearly all glycerine monochlorohydrin, with very little dichlorohydrin.

While this procedure was simple, it was not too well adapted to large-scale continuous operation. One of the difficulties was the problem of heat removal, since the reaction is highly exothermic. This matter was satisfactorily solved by use of a tower reactor, with recirculation of part of the product through a cooler. In operation the tower was kept filled with a gaseous chlorine as the continuous phase, while the aqueous solution descended over the packing. This arrangement functioned quite smoothly, and the temperature could be maintained easily at 15° C.

It still remained to make the hydrolysis to glycerine a continuous process. This was accomplished by simultaneously feeding the unneutralised chlorohydrin solution and an aqueous alkali containing 10 per cent. NaOH and 1 per cent. Na_2CO_3 to a small stirred autoclave that was kept liquid full. Product was withdrawn at the same rate as the feed, passed through an unstirred, heated vessel to complete the reaction, and then removed from the system. The maintenance of accurate alkalinity conditions, times of contact, and temperature, are important here.

It is not sufficient, however, merely to prepare glycerine; it is also essential that the glycerine produced satisfy the most stringent commercial specifications. After some rather remarkable early results successful production of the simple chemical entity 1,2,3-trihydroxypropane has now been attained. Working out the details of the purification process was a rather tedious job, for a whole week elapsed from the start of the chlorohydrination step to the isolation of finished glycerine. However, by methodical elimination of all unfavourable conditions a satisfactory procedure was developed.

The glycerine hydrolysate is concentrated in much the same way as soap glycerine lyes, and then vacuum-distilled. This leads to a crude glycerine which does not yet meet commercial specifications. However, by making appropriate cuts during the distillation, extracting with a solvent such as xylene (U.S.P. 2,154,930), and redistilling, a glycerine is secured which meets all commercial specifications. The ultimate overall yield of finished glycerine from allyl alcohol or allyl chloride is about 90 per cent., and the material is equal to or better than any glycerine offered in the market.

At the time of writing the details of pilot plant operation for this last step in the glycerine synthesis cannot be disclosed, as so much of the operation of an economic glycerine process depends on precise engineering and operational techniques, disclosure of which at this time would be contrary to the national interest. It is hoped that this last step may be discussed in greater detail at some more opportune time.

LIMITATION OF SUPPLIES

To enable the Board of Trade to obtain further information about the distribution of goods controlled under the Limitation of Supplies Orders and to assist them in taking action in cases where goods are illegally supplied in excess of a registered person's quota, they have issued general directions under the Limitation of Supplies (Miscellaneous) (No. 5) Order. Manufacturers who, during the restriction period of December 1, 1940, to May 31, 1941, have supplied or who supply another registered person with controlled goods of a value exceeding by more than £1000 the value of the goods of the same class supplied to that person during the standard period of December 1, 1939, to May 31, 1940, are now obliged to notify the Board by March 1 or within 14 days of supplying the goods. Similarly, retailers who have been or are supplied with controlled goods in the circumstances stated are also obliged to notify the Board, but goods supplied under Open General Licences or against declarations made by the retailer on account of stocks lost through enemy action are not to be taken into account. Registered persons who lose, whether through enemy action or otherwise, any books or records containing particulars of dealings in controlled goods during the standard or restriction periods are required to give written notice to the Board within 14 days.

Fractional Distillation of Fatty Acids*

A Major Step Towards Commercial Purity

THE desirability of providing pure fatty acids as chemical raw materials directed the attention of the research staff of Armour and Co., of Chicago towards improved methods of production for these acids. Hydraulic pressing and simple distillation in cast-iron pot stills are the time-honoured methods of production, but the acids so produced were far from being pure. Commercial pressed stearic acid, for example, contains about 60 per cent. palmitic acid and 40 per cent. stearic, while simple distillation produces purified acids which are light in colour, but still have the same fatty acid composition as the original crude acids.

A major improvement over this type of simple distillation has been the development of the fractional distillation process. In this process the distillation is carried out in such a manner that not only are the non-volatile impurities removed, but the component fatty acids themselves are separated into purified fractions according to their boiling points. This process is the most effective method now known for the purification of fatty acids, and is covered by many patents. The fractional distillation process is not limited in its choice of raw materials and almost all the naturally occurring fatty acids can be purified by this process. If, in addition, hydrogenation procedure is utilised, acids such as arachidic and behenic, which occur only rarely in nature, can be produced. When we consider the versatility of this method, it is easy to see why a great number of new fatty-acid products have now appeared on the market. This new technique of fractional distillation of fatty acids has opened up an entirely new field of aliphatic chemistry. Fatty acids of a purity high enough to serve as chemical raw materials made their advent in commercial circles about five years ago. The derivatives of these pure fatty acids, both actual and potential, are myriad and offer almost unlimited possibilities for application in every field of chemistry.

The economics involved in the production of fatty acids by the fractional distillation process are also worthy of consideration. The process could not succeed on a volume basis unless raw material and production costs were favourable. In the beginning costs were high, as despite the fact that abundant supplies of relatively cheap raw materials were available, this advantage was largely offset by excessive production costs. Now constant improvement in both methods and processing equipment have materially decreased these costs, so that to-day, in many cases, fractionally distilled fatty acids are available at no greater cost than ordinary straight distilled mixed fatty acids.

Commercially pure saturated fatty acids available include the acids from caprylic to stearic, with the probability that in the near future this will be extended to cover the commercial production of arachidic and behenic acids. These pure commercial acids and their derivatives such as alcohols, aldehydes, ketones, esters, metallic salts, nitriles, amides, amines, etc., are daily growing in importance. Synthetic perfume oils, essences, flavours, disinfectants, non-toxic insecticides, flotation chemicals, synthetic resins, dyestuffs, pharmaceuticals, cosmetics, solvents, plasticisers, emulsifying agents, lubricants, rubber compounding, paints, varnish, enamels, waxes, cutting oils, etc., are all fields where their worth is now established.

Another outgrowth of the fractional distillation process has resulted in the production of purified unsaturated acids, and while these products are more highly specialised as to their applications, their importance is inestimable, particularly when national economy demands the wider utilisation of domestic raw materials.

The recent widespread development and application of alkyd resins in the protective coating industry, for example, has created a demand for improved unsaturated acids. Unsaturated acids consisting mainly of linoleic acid have been developed for non-yellowing baking white finishes for refrigerators, hospital equipment, etc. Other fatty acids are specially adapted for use with urea-formaldehyde and the new melamine resins. Another development of economic importance has been the reconstruction of these new unsaturated acids to their corresponding triglycerides, thus making available new synthetic drying oils from hitherto unimportant domestic sources. Commercial products in the drying-oil field now comprise synthesised rapid-drying oils from marine oils which have greatly alleviated the present tung oil shortage and, in the near future, synthetic oils from fractionally distilled soya-bean fatty acids to augment the inadequate domestic production of linseed oil.

* Adapted from an article by D. V. Stingley, of Armour and Co., in *Chemical Industries*, 1941, *48*, 1, pp. 50-52.

Alleged Trading with the Enemy

Chemical Company Fined

ON Friday last week, at the Central Criminal Court, before Mr. Justice Wrottesley, Miss Doreen Grant Gibbons, company director, pleaded guilty to a number of counts charging her with having financial and commercial dealings for the benefit of the enemy. She pleaded "Not Guilty" to other counts in the indictment. Her plea was accepted by the prosecution, and she was bound over for two years in her own recognisances. A similar plea was entered on behalf of Metal and Electro-Chemical Products, Limited, of London, and the company was fined £700.

This was the second time the defendants had appeared before the Court, a jury at the last session having found Miss Gibbons and the company "Not Guilty" on three of the twelve counts in the indictment, and disagreed on the remaining nine counts.

Articles on "Rivet Cutting with the Hand Blowpipe," "Fundamentals of Flame Hardening" and "Rebuilding Conveyor Chain Links" are included in "Oxy-Acetylene Tips" for January, published by the LINDE AIR PRODUCTS CO., New York.

Acrolein from Propylene

Production on a Commercial Scale

IT has been known for a long time that propylene can be converted into acrolein by treatment with mercuric sulphate in presence of a hot mineral acid, a reaction first discovered by Denigès in 1898. This process, hitherto only practicable on the laboratory scale, has now undergone a number of improvements with a view to operation on a large scale where important factors include economic recovery of the valuable mercury salt and rapid removal of the acrolein from the hot reaction zone. According to U.S.P. 2,197,258/1940 (Du Pont) the acrolein evolved after passing propylene through the hot acid solution of mercuric sulphate is swept out in a stream of nitrogen and absorbed in water from which it is recovered in the pure state by fractionation. During the reaction a sludge containing the mercury in the form of mercurous sulphate is deposited. Mercuric sulphate is regenerated from the latter, according to B.P. 531,001/1941 (Acrolein Corporation), by oxidation in an electrolytic cell of the diaphragm type using a fairly high current density. Another novel feature of the latter specification is the employment of an excess of propylene gas which dilutes the acrolein on formation and rapidly removes it from the high temperature zone. The acrolein is finally separated by scrubbing the mixed gases with cold water and fractionating the aqueous solution.

LETTERS TO THE EDITOR

Coumarone Resins

SIR,—Our notice has been drawn to the concluding remarks of an article headed "The Plastics Industry in 1940," in your January 11 issue.

While the manufacture of true coumarone resins of the pale variety has not been established in this country, we should like it to be known that for some long time now we have at our Sunderland works manufactured a dark coumarone resin both in solid and liquid form. The consumption of these dark resins has been extending during the present time, and we are in a position to supply reasonable quantities and shall be pleased to learn of any additional outlet.—Yours faithfully,

MONSANTO CHEMICALS LIMITED.
A. D. DAYSH, Director.

Victoria Station House,
London, S.W.1.
February 14, 1941.

Oil Fuel and Lubricants

SIR,—Sir Percy Alden stated in Leeds a few days ago that "we ought to begin to produce oil from coal on a large scale." Government Ministers often speak of synthetic oil from coal. What is this oil? A Government Minister has stated that the German shortage of lubricating oil is partly due to the bombing of coal distillation plants. Officials appear to believe that lubricating oil suitable for aeroplanes is made from coal; this is a mistake—a very serious mistake.

A writer in an aeroplane journal has gone so far as to state the yearly quantity of oil Germany obtains from coal. Products obtained from coal have not the greasy nature of petroleum products, and are not used for lubrication even when not subjected to heat. Petroleum oils are "saturated hydrocarbons," and do not readily change their physical properties when subjected to heat or even strong chemicals. On the other hand, coal tar products are sensitive to heat and chemicals, usually producing tarry deposits which would have disastrous effects even in a water-cooled motor engine.

The ignorance of men in authority with regard to scientific information is truly astounding. The classical example during the last war was that of the Minister who stated in Parliament that allowing fats to go into Germany had no war value. So the Germans laughed, and made nitroglycerine to kill our soldiers. No fat—no nitro-glycerine. Another instance: Mr. Dalton recently stated that it was no good bombing the Rumanian oil fields, because the crude oil is not inflammable (one report said "not highly inflammable"). I have seen an oil well in Texas burning twenty miles away. Even after the highly inflammable petrol, spirits, oils and waxes have been distilled off the crude oil, the residue is classified in America as "Fire hazard—dangerous."

Meanwhile, two Government research chemists state that recovered oil can be made equal to new, so the shortage of lubricating oil in Germany may not be as serious as the Minister of Economic Warfare believes.

Benzol is, of course, obtained from coal; this with petrol is suitable for motor transport, but not for aeroplanes, which have no water-cooling system. By hydrogenation, benzene can be converted into cyclohexane. I have never heard of cyclohexane being used by aeroplanes, but I think it might be utilised. Unlike benzol, there is little or no sooting from this material. Hydrogenation is a fairly expensive process; to-day cyclohexane costs 6s. per gallon, but large-scale production would, of course, considerably reduce this price.

Petroleum crude oil is subjected to heat decomposition (known as cracking), and then to hydrogenation, which considerably increases the quantity of lower boiling hydrocarbons suitable for air and road engines. Such treatment increases the octane value which is essential for the efficiency of aero-engine fuel; without it, heating, pre-ignition, and knocking will occur which will reduce the life of the plane. But the special value of high octane petrol is that it enables an engine to run with high compression which plays a very important part in speed, mileage, and safety during long flights, also in the liveliness, speed, response, and manœuvring of the plane when attacked.

Just as the last war developed the aeroplane, this war will bring a new standard to motor car engines. High compression will give great power even to small horse-power cars and a considerable reduction of petrol consumption. It is considered that up to 90 per cent. of the power in petrol is lost under present conditions.—Yours faithfully,

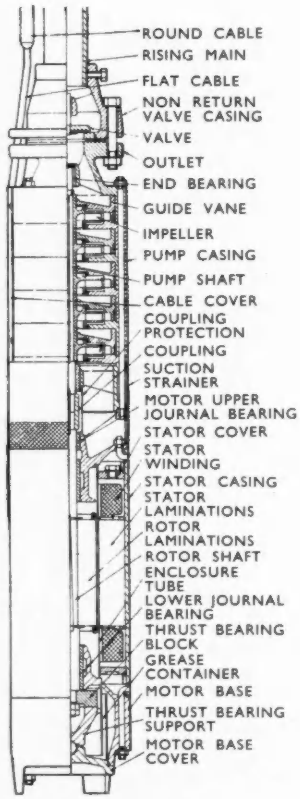
"Hillcrest," Sandhills, F. HULSE, F.C.S.
Thorner, Yorks.
February 13, 1941.

Safeguarding Water Supply

Advantages of Submersible Electro Pump

AN independent, automatically-operated water supply is at all times a great asset and this is particularly so in these days, when interruption of the normal water supply may cause serious production delays.

There are many different methods of raising water to the surface from deep levels, but most possess inherent disadvantages—even the vertical spindle centrifugal pump is encumbered by a long multi-bearing shaft. On the other hand, the "Sumo" submersible electro pump, which may be used for deep-well pumping where alternating current is available, is simple in design, operation and maintenance and it is not surprising that since its introduction thousands have been installed. It has many advantages of importance to chemical works and for fire fighting, etc. The pump and motor are suspended in the well or borehole on the rising main, below the pumping water level, no foundation or pump-house being needed. The industrial types will work without attention for about 6000 hours and are noiseless in operation. Although current consumption is low and there are the fewest possible bearings and the minimum of piping and wiring, the maximum volume of water can be raised.



Working diagram of the "Sumo" Submersible Electro Pump

Personal Notes

MR. C. E. KEIGHLEY, publicity manager to Amalgamated Relays, Ltd., has relinquished his position to join the sales staff of H. Hankey and Co., manufacturing chemists, Standish Street, Burnley.

Gold medals of the Chemical, Metallurgical, and Mining Society of South Africa have been presented to MR. G. HILDICK-SMITH and DR. A. MAVROGORDATO, for their work in connection with mine-dust problems, and to DR. R. A. PELLETIER for his paper on the association of gold and pyrrhotite in the Rand ore.

MR. E. ERIC BILLINGTON, J.P., M.Sc., F.I.C., M.I.Struct.E., managing director of Edward Billington and Son, Ltd., sugar refiners, has been elected president of the Seed, Oil, Cake and General Produce Association, Liverpool, for a second year. MR. ARTHUR ROBINSON, managing director of Meade-King, Robinson and Co., Ltd., oil merchants, was elected vice-president.

MR. ARTHUR B. PURVIS, who before the war in charge of Imperial Chemical Industries' interests in Canada, has been elected chairman of a new committee called the British Supply Council in North America, which has been set up on account of the reorganisation of the British supply organisation in the U.S.A., owing to the larger volume of supplies which have to be dealt with.

PROFESSOR JAMES BRYANT CONANT, President of Harvard University, who is one of the foremost of the leaders in the American movement to give aid to Britain, has left for London at the head of a special mission appointed by President Roosevelt to expedite direct to Washington "recent scientific information of importance to national defence." Professor Conant is well known in the field of organic chemistry and served in the last war as a major in the chemical warfare service. He specialised then in mustard gas and perfected the preparation of lewisite; his less military researches have dealt, among other things, with hæmoglobin and chlorophyll. MR. FREDERICK L. HOVDE, of Rochester University, who is also coming to London as permanent secretary of the mission, is likewise a chemist.

OBITUARY

MR. C. HAROLD WILLS, chief metallurgist of the Chrysler Corporation, has died in Detroit, aged 61. Mr. Wills was a chemical engineer and developed the commercial uses of vanadium steel and molybdenum steel.

DR. HERMAN E. FALK, for over 50 years a director of Salt Union, Ltd., died recently at Oxford, aged 85. He joined the board of Salt Union in 1888, and retired when that concern was taken over by I.C.I., Ltd., in 1937.

MR. STEPHEN LOUIS, assistant treasurer of the Monsanto Chemical Co. of America since 1929, died in St. Louis, Missouri, last month, aged 60. Mr. Louis was a native of France, where his mother and three sisters survive him, but he went to the U.S.A. in 1898, and joined Monsanto in 1917.

MR. HENRY COLEMAN HEAD, M.Inst.Chem.E., who died on February 13, aged 68, after a prolonged illness, was for many years engineer and managing director of the Winchester Water and Gas Company, which was absorbed by the Southampton Gas Light and Coke Company. He was a member also of the Institutions of Civil Engineers and of Mechanical Engineers.

MR. KENNETH FRASER, who died suddenly on February 17 at his residence, Tregullow, Oakwood, Leeds, at the age of 67, was vice-chairman and managing director of the Yorkshire Copper Works, Ltd., Leeds, and a notable figure in the metallurgical world. A native of Stockton-on-Tees, he received his commercial training with the Stockton Malleable Iron Co., Ltd., and later had a share in the management of Elliot's Metal Co., Ltd., Birmingham. He was vice-president and Leeds branch chairman of the Federation of British Industries, and was prominent in many Leeds activities, having served on the council of the Chamber of Commerce in 1928-9 and from 1936 onwards. Latterly he had been an energetic worker in the cause of the National Savings Movement in Leeds, being chairman of the local committee and organiser of the very successful War Weapons Week (the first in the country) last September.

New Control Orders

Export of Certain Ores, Asbestos, etc.

THE Export of Goods Control (No. 4) Order (S.R. & O, 1941, No. 173), which comes into force on February 27, prohibits export without licence of aircraft streamline wires and tie rods, uranium ore, and parts of gauges and measuring instruments of precision.

Export licences will also be required for export to certain destinations of gum damar, beryllium ore, bismuth ore, mercury ore, silver ore, insulated electric wire and cables, and these articles made wholly or mainly of asbestos: brake and clutch linings, cloth and yarns, fibre jointing, packing and lagging.

Mercury Products

The Minister of Supply has made the Control of Mercury (No. 5) Order, 1941 (S.R. & O. 1941, No. 152), which revokes the Orders (Nos. 1 to 4, 1939-40) previously in force. Under the new Order, which came into force on February 10, the amount of mercury sulphide, red, which may be purchased or manufactured by any one person without licence is restricted to an aggregate of 7 lb. in any one calendar month. By the same Order, maximum prices for mercury products (as listed on page 117 of this issue) are fixed according to quantity.

Invert Sugar Prices

An amendment to the Schedule of the Invert Sugar (Maximum Wholesale Prices) (No. 2) Order, 1940, issued by the Minister of Food (see THE CHEMICAL AGE, January 18, 1941, p. 48), fixes maximum prices as follows: Invert No. 1 Sugar, 50s. 9d. per cwt., in 1-cwt. to 4-cwt. casks; Invert No. 2 Sugar, 49s. 9d. per cwt., in 1-cwt. pails; Invert No. 3 Sugar (including black), 48s. 9d. per cwt., in 1-cwt. paper sacks.

Splitting of Greases and Tallows

The Minister of Food has made an Order prohibiting the saponification or splitting of home melt greases or home melt technical tallows except under licence. The Order comes into force on March 1. Soapmakers, fat-splitters, etc., wishing to saponify or split these materials, should apply immediately for the necessary licence to the Ministry of Food, Oils and Fats Division, Pwllycrochan Hotel, Colwyn Bay, Denbighshire.

Dyestuffs

The Control of Dyestuffs Order, 1941, which came into force on February 10, states that nothing in the Control of Dyestuffs Order, 1939 (THE CHEMICAL AGE, October 21, 1939, p. 293), shall apply to imported synthetic phenol.

MELTING RANGE OF FATS

A photoelectric method for the determination of melting-points of fats, by which the present lack of consistency between the results of different observers using the capillary tube method may be avoided was described, at the last meeting of the Society of Public Analysts and other Analytical Chemists, by K. A. Williams, B.Sc., F.I.C. The fact that melting starts at a temperature below the visual melting-point was confirmed by a modification of the dilatometric method, which led to reproducible and definite results for the true incipient and complete melting points. The possible use of figures for change in volume on melting and for the rate of change of density with temperature during melting was suggested as a means of characterising fats.

General News—From Week to Week

THE EMPLOYEES OF the Glenboig Union Fireclay Company, Glenboig, have contributed £104 to West of Scotland charitable institutions.

THE GOODWILL, TRADE MARKS AND STOCK, etc., of Lacco Proprietors, Ltd., manufacturers of "Jet Glaze," have been purchased by F. Hulse and Co., Ltd., advisory and research chemists, Woodlesford, Leeds.

THE OFFICES OF THE Trading with the Enemy Branch (Treasury and Board of Trade) have moved from Imperial House and Alexandra House, Kingsway, to 24 Kingsway, London, W.C.2. Tel.: HOLborn 4300. Cables: Tradenemy, London.

LORD RAYLEIGH ANNOUNCES, in a letter to *The Times*, that he is collecting material for a life of the late Sir J. J. Thomson, O.M. He asks for the loan of any interesting letters from him, which should be sent to Lord Rayleigh at Terling Place, Chelmsford, Essex. They would be copied and returned as soon as possible.

A NEW TRADING WITH THE ENEMY (Specified Persons) Order (S.R. and O., 1941, No. 79) contains the names of about 2700 persons in neutral countries with whom it is unlawful to have dealings of any kind. This order revokes all previous similar orders and contains about 80 additional names as well as some deletions.

THE BRITISH ALUMINIUM CO., LTD., announce the following changes in branch office addresses: The Birmingham office is removed from Lawley Street to Lansdowne House, 41 Water Street, Birmingham, 3 (Tel.: Central 3053-4). The Bristol office and warehouse are closed temporarily. The London office is removed from Norfolk House to Trafalgar House, Waterloo Place, London, S.W.1 (Tel.: ABBey 1365).

THE OFFICIAL PRICES FOR MAGNESITE now in force, basis delivered consumers' works in this country, are, states the *Metal Bulletin*, as follows: Greek raw magnesite £9 10s. per ton; African raw magnesite £9 7s. 6d.; Australian raw £9 5s.; Greek calcined £18 15s.; Indian B.S. fires £19 5s.; Indian S.C. lump £19 15s.; Indian G.C. fines £22 15s.; Indian C.M. fines £18 5s.; Australian dead burnt £18 15s.; and synthetic magnesite £18 7s. 6d.

Foreign News

IMPORTS OF ACETONE into Argentina during 1939 increased sharply to 287,747 kg., from 55,168 kg. in 1938.

THE FIRST BARREL OF TOLUENE from America's first petroleum toluene refinery, in Houston, Texas, was taken off in December last, more than a month ahead of schedule, according to an announcement by the Shell Oil Company.

A NEW COMPANY, the Nordische Aluminium A.G., has been formed in Germany with a capital of RM.20,000,000 for the production, manufacture and fabrication of light metals, particularly aluminium and its alloys.

THE S.A. ITALIANA POTASSA, a company engaged in the production and sale of potassium salts, has amalgamated with the Vulcania concern, which has hitherto been engaged in the exploitation of volcanic minerals for industrial purposes.

THE SOCIETA METALLURGICA ITALIANA, of Rome, showed net profits for the year ending September 30 last of 16,250,000 lire, compared with 14,090,000 lire in the preceding year. A dividend of 16 per cent., compared with 14 per cent., was distributed.

INDUSTRIAL CHEMICALS alleged to be in short supply in Japan include ammonium carbonate, boric acid, ethyl acetate, nitric acid, potassium bichromate, potassium permanganate, sodium peroxide, sodium sulphide, and tartar emetic. The shortage of nitric acid is said to be due to the scarcity of shipping containers.

A NEW REGULATION IN GERMANY provides for certain changes in the composition of washing powders and laundry soda: soaking and rinsing powders must now be of such a composition that, at a concentration of 2 to 5 gm. per litre, their pH value does not exceed 11.0 and they must be readily soluble in water. In exceptional cases, soaking powders may have a pH value of 11.5 at the above-mentioned concentration. Soda for soaking (Bleichsoda) must contain from 45 to 50 per cent. sodium carbonate and from 15 to 45 per cent (38° Bé.) sodium silicate.

A NEW RUST-PROOF PAINT has recently been introduced by a leading German chemical concern. The preparation of the new paint is covered by a German patent and the outstanding characteristic of the product is that it incorporates zinc ferrite as the rust-proofing ingredient. It is reported to contain 79 parts zinc ferrite, 16 parts linseed oil varnish, and 5 parts thinning agent.

SULPHATE OF POTASH, a shortage of which was threatened on the cessation of European imports, is now being commercially produced in the U.S.A. from langbeinite, a double sulphate of potassium and magnesium. This is mixed and processed at Carlsbad, New Mexico, by the Union Potash and Chemical Company.

SWISS EXPORTS OF DYESTUFFS during 1939 totalled 7,687,393 kg., worth 104.4 million francs, as against 6,005,319 kg., and 81.3 million francs for 1938. During 1939 British purchases of Swiss dyestuffs were 947,426 kg., value 14.3 million francs, while trade with British India was 326,011 kg., worth 4.97 million francs.

INDOLE, AN IMPORTANT CONSTITUENT of many perfumes, is now being manufactured in the United States by E. I. du Pont de Nemours and Co., as a synthetic product of coal and nitrogen. The grade produced is claimed to be equivalent in purity, strength and odour to supplies formerly imported from Central Europe.

THE PRODUCTION OF PLATINUM METALS in Alaska in 1940 showed a considerable increase over 1939. According to preliminary estimates of the U.S. Geological Survey, Alaska production in 1940 amounted to 28,860 fine ounces having a value of approximately $1,092,000. This output places Alaska among the largest platinum-producing countries in the world. Some platinum metals, mainly palladium, are recovered from Alaskan ores carrying accessory values in gold and copper.

AN INTERESTING SURVEY of the experimental plantations of tung trees (*Aleurites fordii*) in Cyprus is the leading feature of the latest *Bulletin* of the Imperial Institute (October-December, 1940). Dr. S. G. Willimott, for many years Government Analyst in the island colony, describes the results from the plantation at Polis, which was started in 1931. Provided that summer irrigation can be maintained, there is no obstacle to successful production of tung oil, and analytical data show that the oil produced is of excellent quality, equal to that from American plantations and superior to the ordinary commercial oil from China.

THE FIRST NITROGEN FIXATION PLANT in Denmark is to be located near Thisted in Jutland, which is believed to offer the most advantageous situation for the new Danish calcium nitrate industry. The plans, which are as yet in a preliminary stage, call for a combination of the nitrogen plant with a new gas works, which will supply all northern Jutland with gas and coke. The cost of the gas works, the plans for which are well advanced, is estimated at about 850,000 kroner and that of the fertiliser factory at a little over 2,000,000 kroner. It appears that the fertiliser factory is to be of the same type as those operating in Germany and Belgium in conjunction with gas and coke works.

Forthcoming Events

A LUNCHEON MEETING of the Newcastle Section, Society of Chemical Industry, will be held at the Royal Turk's Head Hotel, Newcastle-on-Tyne, on February 27, at 12.45 p.m. Luncheon will be served at 1 p.m. prompt (tickets 5s.). At 1.45 p.m., a short paper of 15 minutes, entitled "The Use of Cyclohexanol in Molecular Weight Determinations," by H. N. Wilson and A. E. Heron, will be read. Following this, Dr. W. Hook will read a paper on "Gravity Separation of Coal with Special Reference to the Barvoys Process."

THE ANNUAL MEETING of the Society of Public Analysts and Other Analytical Chemists will be held in the Chemical Society's Rooms, Burlington House, Piccadilly, London, on March 7, at 3.45 p.m., and will be followed at 4.30 p.m. by an address by Sir Harry Lindsay, K.C.I.E., C.B.E., on "The Work of the Imperial Institute for the British Empire."

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Companies Winding-Up Voluntarily

PEMEXO LABORATORIES, LTD. (C.W.U.V., 22/2/41.) By special resolution, January 17. Mr. Owen Jones, of Hall Bank, Llanfairfechan, appointed liquidator.

Company News

Beralt Tin and Wolfram, Ltd., have declared an interim dividend of 5 per cent.

Peter Brotherhood, Ltd., have declared an interim dividend of 8 per cent., less tax, on ordinary shares (last year the same).

Lightalloys, Ltd., have declared an interim dividend of 12½ per cent. (same).

Borax Consolidated, Ltd., have decided to pay, in respect of the year ended September 30, 1940, the following dividends, less tax: a final dividend of 3 per cent., making 6 per cent. for the year, on the preferred ordinary stock; and a dividend of 7½ per cent. on the deferred ordinary stock. Net profits for the year were £464,148 (last year £425,644).

Chemical Trade Inquiries

Argentina.—An agent established at Buenos Aires wishes to obtain the representation, on a commission basis, of United Kingdom manufacturers of industrial and fine chemicals. (Ref. No. 69.)

Spain.—An agent established at Barcelona wishes to obtain the representation of United Kingdom manufacturers of chemicals and dyestuffs. (Ref. No. 65.)

New Companies Registered

Bio-Colloids, Ltd. (365,234).—Private company. Capital £100 in 100 shares of £1 each. Manufacturers of and dealers in chemicals, gases, drugs, medicines, etc. Directors: Jas. F. Moseley; Desmond Allen. Registered Office: Old Warehouse, Altrincham Bridge, near Manchester.

Fire Equipment, Ltd. (365,340).—Private company. Capital £500 in 500 shares of £1 each. Manufacturers of and dealers in fire extinguishers, chemicals, etc. Subscribers: Sam Holden; Mrs. Olive A. Jones; Samuel Barlew. Solicitors: G. Ruddin and Co., 55 Brown Street, Manchester, 2.

Roberts Orme & Co., Ltd. (365,282)—Private company. Capital £2000 in 2000 shares of £1 each. To acquire the business of a chemical manufacturer, merchant and distributor carried on by Frederick Roberts Orme, at 15, Clare Street, Bristol, as "Roberts Orme and Co." Directors: Frederick Roberts Orme, Eldon, Long Ashton, Bristol; Wiliam E. Stevens; Ivor B. Bollom. Solicitors: Bayliss, Rowe and Co., Bristol.

Chemical and Allied Stocks and Shares

THE developments in the Balkans and the Far East have governed sentiment in the stock and share markets, and although selling was not heavy, security values tended to lower prices in the absence of demand. The view prevails that, apart from British Funds and other high-class securities of the fixed interest type, there is little prospect of any material increase in activity owing to the widespread tendency to await the Budget.

Despite the reactionary trend on the Stock Exchange, movements in many leading shares of chemical and kindred companies were small and unimportant. Imperial Chemical at 29s. were little changed, it being pointed out that on the basis of the 8 per cent. dividend, which is expected to be maintained, the yield compares favourably with that on many other leading industrial shares. I.C.I. 7 per cent. preference units at 33s. 3d. were unchanged on balance for the week. Moreover, Borax Consolidated deferred units remained firm at 28s. 9d., aided by satisfaction with the maintenance of the distribution at 7½ per cent. B. Laporte changed hands at 56s. 3d. and Fison Packard were 32s. 6d., while Goodlass Wall were again 10s. British Oxygen regained an earlier reaction and at 65s. were unchanged on balance, the market being hopeful that the dividend may be only slightly below the 17 per cent. paid for the previous year, when the capital in issue was smaller. British Aluminium were easier at 41s. 3d. and British Match at 29s. 3d. recovered part of last week's decline. Imperial Smelting were again 11s. 3d., but at 8s. 1½d. General Refractories lost part of their recent improvement. Pinchin Johnson were lower at 18s. 6d., although pending the dividend announcements, both International Paint and Indestructible continued to be well maintained in price.

Lever & Unilever at 22s. 3d. were slightly lower on balance, but British Oil & Cake Mills preferred ordinary held their recent improvement to 37s. and at 52s. 6d., Nairn & Greenwich have also kept the better price made last week. Moreover, Barry & Staines were 26s. 10½d. Turner & Newall, however, were slightly lower at 66s. 3d. and United Molasses eased to 24s. 3d., although the market remains very hopeful that the dividend on the last-named may be unchanged. The ordinary units of the Distillers Company, however, were marked down in common with the shares of various other companies whose general prospects may turn largely on the Budget. On the other hand, cement shares were relatively steady, including Associated Cement, which have continued to be aided by the possibility that the dividend may be maintained. British Plaster Board 5s. ordinary, however, were easier at 13s. Iron and steel securities were mostly reactionary, in accordance with the general market tendency this week, but declines were moderate and were attributed mainly to absence of demand, very little selling having been reported. Baldwins 4s. shares continued to be quoted around 5s. (the results are due next month), but Guest Keen were lower at 21s. 6d., and Dorman Long were 17s. 6d. Stewarts & Lloyds were 42s. 6d. and Tube Investments 89s. 9d.

Elsewhere, British Industrial Plastics 2s. shares were again around 2s. 4½d. and British Drug Houses 22s. 6d. Greeff-Chemicals 5s. units were maintained at around 6s. and Monsanto Chemicals 5½ per cent. preference were quoted at 22s. 6d. "middle." British Tyre & Rubber were 39s. 4½d., awaiting the results. It may be recalled that last year it was announced that accounts for the twelve months ended September would probably be available by the end of February, 1941, and that the company's activities had increased in many directions.

Among other securities, Boots Drug 5s. ordinary were lower on balance, the current price being 35s. 9d., while Sangers were 16s. 10½d., and Timothy Whites 19s. 3d., Beechams Pills deferred were steady at 8s. 3d., awaiting the interim dividend announcements of leading subsidiary companies. "Shell" and other leading oil shares reflected the reactionary conditions on the Stock Exchange this week.

British Chemical Prices

Market Reports

THERE have been few price changes of any importance in the chemical market during the past week, and in most sections trade is reported to be moderately good with the volume of export enquiry much in excess of available supplies. In both the potash and soda sections the demand is influenced by the supply position and rather more enquiry is circulating for chlorate of soda, with offers of this product difficult to secure. A brisk demand is in evidence for acetone and formaldehyde, with the latter firm in quotation. Elsewhere the tone continues strong. A moderate business has been transacted in the coal tar product section, activity being chiefly centred on such items as creosote oil, carbolic acid crystals, xylol and solvent naphtha. Prices for pyridine and cresylic acid are well held on a quiet demand.

MANCHESTER.—Actual further upward movements of prices on the Manchester chemical market during the past week have not been numerous, but there is no disputing the fact that in virtually all sections the undertone is extremely firm. The soda products have met with a steady demand, as have also most of the heavy acids, whilst available supplies of potash materials have moved steadily into consumption. A wide range of textile chemicals this week has met with a fair demand. Crude tar, creosote oil, and the light distillates generally have been active sections of the by-products market here, and values have been strong.

GLASGOW.—There is no change in the position of the Scottish heavy chemical trade either for home or export business. Prices keep firm.

Price Changes

Antimony Sulphide.—Golden, 10d. to 1s. 6d. per lb. Crimson, 1s. 9d. to 2s. per lb.

Arsenic Sulphide.—Yellow, 1s. 9½d. per lb.

Cadmium Sulphide.—5s. 5d. to 6s. 6d. per lb.

Carbolic Acid.—Crystals, 9½d. to 10¾d. per lb.; Crude 60's, 3s. 6d. to 3s. 9½d., according to specification.

Carbon Black.—5d. to 8d. per lb., according to packing.

Creosote.—MANCHESTER: 5¼d. to 7¼d. per gal.

India Rubber Substitutes.—White, 5¾d. to 8½d. per lb.

Lamp Black.—£45 per ton.

Mercury Products.—Controlled price for 1 cwt. quantities: Bichloride powder, 11s. 7d.; bichloride lump, 12s. 2d.; ammon. chloride powder, 13s. 5d.; ammon. chloride lump, 13s. 3d.; mercurous chloride, 13s. 9d.; mercury oxide, red cryst. B.P. 15s. 6d.; red levig. B.P., 15s.; yellow levig B.P., 14s. 11d.; yellow tech., 14s. 4d.; sulphide, red, 12s. 11d.

Methylated Spirit.—Industrial 66° O.P. 100 gals., 2s. 0½d. per gal.; pyridinised 64° O.P. 100 gals., 2s. 5d. per gal.

Naphthalene.—Crude, whizzed or hot pressed, £14 per ton; purified crystals, £27 per ton in 2-cwt. bags; flaked, £27 per ton. Fire-lighter quality, £6 10s. to £7 10s. per ton ex works.

Pitch.—Medium, soft, nominal, f.o.b.

Sulphur.—Finely powdered, 17s. per cwt. d/d.; precip. B.P. 68s. per cwt.

Turpentine.—American, spot, including tax, ex wharf, in barrels, and ex disct., 68s. 6d. per cwt.

CLASSIFIED SECTION

NOTE: Trade announcements, other than strictly second-hand and job lines, cannot be inserted in these pages except by firms whose advertisements run in the display columns

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C.I. JACKETED VACUUM PAN, 200 gallons; Jacketed Steel Mixing Autoclave, 2 ft. 9 in. by 2 ft. 6 in.; Gardner Jacketed Mixer, 7 ft. 7 in. by 2 ft. by 2 ft. 3 in.; Sissons Dough Mixer, 24 in. by 16 in. by 18 in.; Bonecourt 3 B. Gas Fired Boiler.

HARRY H. GARDAM & CO., LTD., STAINES.

CHARCOAL, ANIMAL, and VEGETABLE, horticultural, burning, filtering, disinfecting, medicinal, insulating; also lumps ground and granulated; established 1830; contractors to H.M. Government.—THOS. HILL-JONES, LTD., "Invicta" Mills, Bow Common Lane, London, E. Telegrams, "Hill-Jones, Bochurch, London." Telephone: 3285 East.

125 KILOWATT GENERATING SET, 250-volts D.C 500 amps. direct coupled to an Allan 4-cylinder, bulb-start Crude Oil Engine. Dartnall, 248 Humberstone Road, Plaistow, London, E.13.

1000 STRONG NEW WATERPROOF APRONS. To-day's value 5s. each. Clearing at 30s. dozen. Also large quantity Filter Cloths, cheap. Wilsons, Springfield Mills, Preston, Lancs. Phone 2198.

COMBINED AUTOMATIC WEIGHING, MEASURING and Mixing Plant, with six weighers, capacity about one ton per hour, with 20 h.p. and 7½ h.p. motors, elevator, conveyor, vibro-screen, etc. Can be seen erected in Kent. THOMPSON AND SON (MILLWALL), LTD., Cuba Street, Millwall, London, E.14. East 1844.

600

COPPER Steam Jacketed Tilting Pan, 42 in. dia. at top tapering to 27 in. dia. pan, complete with tilting handle.

Acid Filtering Unit, comprising Lead Lined 1000 galls. welded M.S. Vessel and Lead Lined Hopper Bottom welded M.S. Acid Filter, filter bed 5 ft. 2 in square.

Horizontal Cast Iron Filter Press, 29 cast iron recessing centre feed plates, arranged with side run offs, 8 ft. 0 in. long by 2 ft. 6 in. wide by 4 ft. 0 in. high. FOUR AVAILABLE.

Horizontal Aluminium Mixer, internal dia. 18 in. by 30 in. internal length with two straight mixing blades, fast and loose pulleys 23 in., arranged with bottom discharge lever valve.

Horizontal Copper Mixer, copper cylindrical drum, 32 in dia. by 7 ft. 3 in. long, central copper agitating shaft fitted with bronze blades, pulleys 18 in. dia. by 3 in. face. TWO AVAILABLE.

Horizontal Steam Jacketed Vacuum Dryer, steel pan 8 ft. 7 in. long by 5 ft. 3 in. wide at top by 5 ft. 6 in. deep, 3-bladed agitation, hand worm tilting gear.

Cylindrical Copper Storage Tank, 15 ft. 0 in. by 4 ft. 0 in. dia., totally enclosed, manhole 16 in dia. by 3 in. dia., flanged run off. TWO AVAILABLE.

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50,000 FEET brand new Balata and Rubber Belting, all popular sizes. Every belt guaranteed and sent on approval at bargain prices. Write for stock and price lists, F. Taylor & Sons (Manchester), Ltd., Barr Hill Works, Salford, 6, Lancs.

100 REBUILT Hydro Extractors by all leading makers from 18 in. upwards with countershafts attached and safety covers. Jacketed Steam Pans, various sizes. List on request. Seen at Randalls, Arundel Terrace, Barnes. Telephone: Riverside 2436.

WERNER JACKETTED MIXER, Double Trough Tilting Pan, 30 in. by 30 in. by 24 in. with "Fin" Blades; Similar Unjacketted "2" blade Machine. WINKWORTH FOR MACHINERY, 65 High Street, Staines. Tel. 1010.

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